

## ENGINEERING CONTROLS--ONLY THE BEGINNING

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### ABSTRACT

Designing and installing engineering controls to protect the health of workers is one thing, making them fully functional and reliable is quite another. The authors list four reasons for installing control measures which may be related to the ultimate success of their use: product recovery, protection of employee health, satisfaction of government mandates and survival. A case history is presented to show the progression of management acceptance starting with the plant's efforts to protect the health of workers on their own, through the upheaval of a court ordered compliance program, and ending with the establishment of a management plan to provide a comprehensive program of protection.

### FACTORS THAT AFFECT CONTROL EFFECTIVENESS

When engineering controls are discussed in the technical literature, the subject of the discussion is usually the beginning, i.e., application, design, installation and evaluation. Obviously, the design must be good or the results cannot be good, but let's go on from there.

The continuation of engineering controls, i.e., proper operation and maintenance, is usually lumped into the general category of maintenance and considered separately. Improper operation or poor maintenance are usually blamed for inadequate performance of engineering controls whether or not the design was good. The design obviously can influence the ease of operation and maintenance, but even the best design by no means assures the continued effectiveness of the control.

While effective engineering controls can frequently be provided by expenditure of enough money and talent, the real difficulty of implementing engineering controls is in gaining worker acceptance and in assuring continued operation and maintenance. This problem can be substantially reduced through skillful design of controls with both worker and maintenance

in mind\*. However, with very few exceptions, the presence of an engineering control will in some way interfere with the worker's performance of his job. Unless the health hazard is immediate and severe--a "life hazard"--it is well-known that production will not stop if this piece of equipment malfunctions. The only way the controls will be assured of performing their function on a continuing basis is if the entire plant management is sincerely committed to assigning a high priority to them--equivalent to that for production.

#### REASONS FOR INSTALLING CONTROL MEASURES

For the purpose of this talk, engineering controls may be divided into four classes based on the reasons for implementing them:

Class 1. Those desired for the purpose of product recovery--

This class results in product value and is therefore given a priority equivalent to production. This type of control usually functions as consistently as other production equipment in the same facility, at least in its product recovery aspects.

Class 2. Those perceived by management as being required to protect employee health--

This class is the second highest priority in the plant. The number of controls included in this group and the relationship of their priorities to that of production varies broadly depending on objectives of management and profitability of the company.

Class 3 - Those perceived as important by outside authorities and implemented through the use of force--

This class is often considered unnecessary, ineffective, and/or unworkable by management. The situation is made worse by the stance of some agencies, frequently requiring controls for their own sake regardless of effectiveness or cost, as a "policy" or "political" position. It receives lowest priority and is doomed to failure. It may be doomed anyway because of basic infeasibility, but that is a different problem. The only hope for this class of control is that, where the facts warrant, management can be persuaded to change it to Class 2 or Class 4.

Class 4 - Those considered by management to be effective and workable and perceived to be in the best interests of the company based on the survivor syndrome--

Controls in this group include, for example, those that the manager feels are possible to implement and are required to meet the OSHA standards, even though this manager may feel a particular OSHA standard is unreasonably restrictive and not required to protect the employee's

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\*Caplan, K. J., "Philosophy and Management of Engineering Controls", Vol. III, Chapter 18, Patty's Industrial Hygiene and Technology, 3rd ed. Wiley Interscience, New York 1979.

health. Priority is placed on these controls because if they are not functional, the legal ability to operate will be affected, which in turn will affect the plant's competitive position in the long run.

#### CASE HISTORY EXAMPLE

##### Background

A first-hand case history will be illustrative of a progression of management acceptance and incorporation of the different classes of controls just described. I will begin by characterizing the management of the company which in this case is a secondary lead smelter. The organization, not at all unusual for small companies including many in the foundry and secondary lead industries, comprises a minimum management staff. It is a paternal organization run by well-meaning people who place a very high value on their employees and have a far-reaching reputation as legitimate businessmen. They have, however, a poor reputation with local health officials, probably because they have dealt for some time with a product known to be toxic (lead) and have largely ignored interference by outsiders.

At the plant being described, the situation at the beginning of the case history relative to controls was as follows:

Class 1 controls included filtration and recovery of flue dust which had been used for many years. In this industry, recovery of product from furnace flue dust is required to maintain a competitive position in the marketplace.

Class 2 controls had been installed for some time and were reasonably well maintained as evidenced by the fact that there was rarely a case of lead poisoning occurring. Such controls relied heavily on personal protective devices and were not complete solutions in an engineering sense. Biological monitoring had been in effect for some time and the list of controls included in Class 2 was continually growing as a result of concern over blood leads.

Management had done a good job - from their point of view - of keeping on top of the situation. They regularly visited the plants of competitors to keep abreast of what others were doing in this area. They worked hard to keep their plants "better than most" as it relates to employee health.

##### Government Mandate

With this background, it is understandable that management was upset when OSHA cited them, stating that they were "seriously" endangering their employees' health in most areas of the plant. Not only did they disagree, but they were insulted that anyone would think they would deliberately risk their employees' health. They listened to the ideas suggested by OSHA for coming into compliance, attempted to incorporate what they considered workable, and disposed of the rest. Following expiration of the abatement date, they discovered that OSHA was not satisfied. Under pressure from OSHA for compliance, they indicated that they had done everything they could, that they were on par with most smelters in the

industry, and that further engineering controls were not feasible.

OSHA brought court action against the company, and retained an industrial hygiene engineering consultant for an independent opinion. The consultant produced a report documenting feasible engineering controls required to achieve OSHA compliance. After some negotiation, the consultant's report was adopted as the basis for settlement of the case, and was issued in the form of a court order. The company proceeded to hire an engineering consultant in an attempt to implement the court order, with all the lack of fervor described above for Class 3 controls.

#### Implementing the Mandate

In the initial investigation, upon which the recommendation of feasible controls was made, the consultant had had to accept management statements as to the existing and reserve capacity of the baghouses. It later developed that management had been badly misled by equipment vendors as to the capacity that could be achieved by modifications. This posed special hardships in attempting to fulfill the court mandate.

I (Vincent J. Jacobson) had the good fortune to be assigned this task on behalf of the consulting firm, Industrial Health Engineering Associates. It was a truly exciting experience to work with this company and to watch our relationship grow from mistrust to trust to belief in a common goal as the project progressed. The work done has been substantial, and is briefly outlined as follows:

The battery saw has been replaced with a low speed saw which produces a much lower emission.

Plate storage has been relocated to inside a new building resulting in drastically reduced fugitive emissions (an EPA consideration) and also in reduced exposure to employees working in the general area. The entire plate handling end of the operation has been physically isolated from the rest of the plant. The plate handling operator running a payloader has been supplied with either an air supplied respirator or a clean air cab enclosure.

The dry sweeper which was used throughout the plant and which produced substantial amounts of dust in operation has been supplemented by a central vacuum cleaning system.

Blast furnace and reverberatory furnace tapping have been provided with improved enclosure and ventilation.

The refining kettles have been provided with hoods having significantly improved capture.

Flue dust recycling from the baghouse to the furnaces has been mechanized using a well sealed screw conveyor system.

Gravity roof ventilators have been provided above the reverberatory furnaces to exhaust contaminants from the upper building air spaces.

Make-up air introduced at low velocities to produce a clean air "island" effect has been provided in the blast furnace area.

#### Limited Effectiveness Achieved

Upon installation of these controls, the OSHA court order was satisfied and officially closed. However, the effectiveness of many of the installed control measures was limited.

The material handling isolation included a number of access openings which were usually left open, negating the effectiveness of the isolation. The air-supplied respirators for the payloader operators never did work properly as they were quite cumbersome and suffered from many breakdowns.

The vacuum cleaning system worked extremely well, but due to a manpower shortage and the labor intensiveness of manual vacuum cleaning, it was not performed frequently enough to improve overall plant housekeeping.

The furnace hoods were reasonably well designed and functioned quite well when adequate baghouse capacity was available and access openings were maintained closed, which they routinely were not. Another furnace hood problem was consistency of exhaust capacity which was disrupted by a plugging problem. The original flue gas cooling system was a radiant tube type system with receiver kettles at the ground level junctions. As flue dust settled out of the cooling tubes, the kettles plugged, resulting in dramatically varying system pressure drops and ventilation rates and inadequate performance of furnace hoods.

The flue dust handling system was very satisfactory where it was installed, however, the cooling tube kettles were periodically cleaned using a payloader and that source had not been controlled.

The gravity roof ventilators and make-up air system were also satisfactory where installed, but additional make-up air systems were needed in other areas of the plant.

It could be shown that the lead exposure of virtually every job description in the plant was less than  $200\mu\text{g}/\text{m}^3$ —when things went right. Conversely, workers with virtually every job description had exposures exceeding  $200\mu\text{g}/\text{m}^3$  when things went wrong. This is a case of a complete set of engineering controls having been almost installed and almost implemented. The project was successful in the Class 3 sense in that the terms of the court order had been satisfied.

A decision point had been reached. Management now realized that they could significantly delay the effects of furnace OSHA involvement by hiring a good lawyer and playing legal games. Instead, they chose to become survivors, and began by attacking their most obvious weakness - lack of management coverage. They hired key staff members to improve coverage and expertise in the areas of safety and health, engineering and personnel. As a result, they have been able to improve the stability of the work force which in turn makes training efforts more productive, and makes it possible to more effectively enforce personal hygiene and work practice controls and to implement a comprehensive respirator program.

Hygiene and lunchroom facilities have been rearranged and improved. A new U-tube cooler has been designed and is nearly in operation to improve baghouse capacity and dramatically reduce flue dust handling exposure. Each of the existing engineering controls is in the process of being reassessed and the required detailed changes to make them perform adequately will be implemented.

Long range planning is being done, especially in the area of mechanization of material handling, to reduce employee involvement and, therefore, exposure. A long range compliance plan will soon be developed to provide for planned progress toward the objective of implementation of all feasible engineering controls. It is crucial, however, when discussing these plans to remember that they really are--only the beginning.

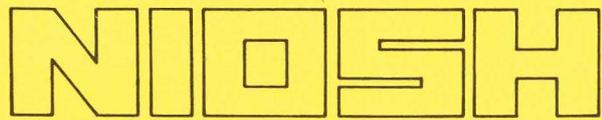
#### QUESTIONS, ANSWERS AND COMMENTARY

Question (J. Talty, NIOSH):

How do you distinguish between Class 2 and Class 4? What would be an example of a Class 2 engineering control?

Answer (V. Jacobson):

The difference I see between Class 2 and Class 4 is the belief that is really required to protect the employee's health. And with the proposed lead standard in the courts, I think it's obvious to everyone that we don't all believe that a standard as low as  $50\mu\text{g}/\text{m}^3$  is required to protect the health of workers.



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